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THE IDENTITY OF THE ROCKY MOUNTAIN *LYCAENA DORCAS-HELLOIDES* COMPLEX (LYCAENIDAE)

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ABSTRACT

High altitude Rocky Mountain *Lycaena* of the *dorcas* Kirby and *helloides* (Bdv.) group have been variously assigned to *dorcas* or *helloides* by different authors. I have attempted to show that all Rocky Mountain material is actually *L. helloides*, both at low and high altitude. Natural larval foodplants for the high-altitude populations were previously unknown; five Polygonaceae plant species are reported from observations in nature. *L. dorcas*, in contrast, is known to feed on *Potentilla* (Rosaceae); *L. helloides* from other regions also feeds on Polygonaceae. Lastly, my data indicate that high altitude material is closest to *helloides* in six of eight wing pattern and wing shape characters, two of the characters being variable.

INTRODUCTION

High-altitude Rocky Mountain *Lycaena* of the *dorcas* and *helloides* group have recently been assigned to *L. helloides* (P. Opler, in Howe 1975), and to *L. dorcas* (Ferris 1977). Earlier authors were uncertain as well. Clench (1961) emphasized the need for careful field studies in the Rocky Mountains, a need which has not been met. I therefore decided to try to clarify the identity of Rocky Mountain populations using foodplant studies and detailed studies of morphology. I found that there are no differences in male or female genitalia between *dorcas* and *helloides*. My studies indicate that high-altitude Rocky Mountain material belongs to *helloides*. Both the larval foodplants and the details of wing pattern and wing shape indicate that high-altitude Rocky Mountain material is closest to *helloides*. High altitude Rocky Mountain populations seem to be rather general feeders on *Rumex* and *Polygonum* (both Polygonaceae), as are populations of *helloides* in most of its range in North America.

My study also indicates a large amount of individual and altitudinal variation in several wing pattern characteristics, which may indicate environmental influences on phenotype and may bring into question some subspecies that have been proposed in the *dorcas-helloides* group; geographic variation seems to involve a combination of genetic and environmental changes which are difficult to unravel.

I use *Lycaena* as the genus name rather than *Epidemia* as does Ferris (1977) because *Lycaena* is a time-honored genus and I think that relationships within the Lycaenidae are better served by treating *Epidemia* and other names as subgenera.

FOODPLANTS — GENERAL

L. dorcas apparently uses mostly *Potentilla fruticosa* (Rosaceae) as its larval foodplant. Larval foodplant records are known for Michigan (*P. fruticosa,* Newcomb 1911), Ohio (*P. fruticosa,* Price 1970), Ontario (*P. fruticosa,* P. M. Catling, W. Edmonds, C. H. Walker 1970 unpublished manuscript), Maine (*P. fruticosa,* Brower 1974, for *L. dorcas claytoni* (Brower)), New Brunswick (*Potentilla,* Klots 1951, for *L. dorcas dospassosi* (McDunnough); Shapiro 1974b states that this supposedly *dorcas* population probably feeds on *Potentilla egedei* var. *groenlandica* or *P. anserina*).

L. helloides, in contrast, feeds almost exclusively on Polygonaceae: *Polygonum aviculare, P. lapathifolium, P. hydropiperoides* (all southern California, Coolidge 1924), *P. aviculare, P. lapathifolium, P. persicaria, P. punctatum* (all central California, Shapiro 1974a), *P. amphibium* (Tietz 1972), *Polygonum* probably *careyi* (Michigan, Clench 1950), *Rumex* sp. (Washington, Robert Pyle, Lepid. News 1976 #2), *R. persicarioides, R. conglomeratus, R. crispus, R. hymenosepalus* (all southern California, Coolidge, 1924), *R. crispus* (central Calif., Shapiro 1974a), *R. acetosella* (Garth & Tilden 1963). A record of *Oxytheca spergulina* (Lembert 1894, apparently cited as *Eriogonum spergulinum* by Tietz 1972) (Polygonaceae) is possible, but records of *Gayophytum diffusum* (Onagraceae, Lembert 1894), *Oenothera binnis* (Onagraceae, Tietz 1972), and *Galium* (Rubiaceae, Klots 1951) are undoubtedly erroneous. *Lycaena* females (except *heteronea* Bdv. and *arota* (Bdv.)) land on the foodplant, crawl down the stem, and lay eggs on stems or trash at or near the base of the plant, which may account for their sometimes laying

eggs on plants not eaten by the larvae. Shapiro (1974b) found that one California salt marsh population feeds on *Potentilla egedei* var. *grandis* and prefers to oviposit on this plant rather than on *Rumex crispus*.

The above foodplant record for *helloides* and *dorcas* suggests that if a population feeds on Polygonaceae it is *L. helloides*, but if it feeds on *Potentilla*, it may be either *L. helloides* or *L. dorcas*.

FOODPLANTS IN COLORADO

I found five species of Polygonaceae serving as hosts for high altitude Colorado *helloides*: 1) *Polygonum aviculare* (oviposition on base of stem at 13:35 standard time at Toll Ranch, 9400', Gilpin Co. Colo., 28 July 1977; oviposition on tiny plant next to *P. aviculare* and *Rumex acetosella* at 13:08, same locality and date). 2) *R. acetosella* (oviposition at base of stem 13:12, same locality and date). 3) *Polygonum douglasii* (oviposition on grass blade touching a *P. douglasii* stem 10:11, Jim Creek, 9400', Grand Co. Colo., 9 August 1977). 4) *Rumex densiflorus* (egg found on dead twig at base of plant, compared and found identical to eggs dissected from females, Keystone Gulch, 9600', Summit Co. Colo., 8 August 1977) (*L. helloides* eggs have a fairly smooth surface with cylindrical holes, whereas eggs of the sympatric *L. rubidus* (Behr) (the only other *Lycaena* present), *L. editha* (Mead), *xanthoides* (Boisduval), and *hyllus* (Cramer) are covered with peaklike bumps connected by lower ridges around the cylindrical depressions). 5) *Rumex triangulivalvis* (egg found on stipule at base of plant, 4 mi. SE of Fall River Reservoir, 10000', Clear Creek Co. Colo., 10 August 1977, egg identical to eggs from dissected females).

Potentilla fruticosa did not grow at the above sites, except for parts of the Keystone Gulch locality. The Keystone Gulch *helloides* often occurred near *P. fruticosa* and other *Potentilla* species, but females did not oviposit on *Potentilla* although both sexes often visited the flowers of *P. fruticosa* and other plants (*Erigeron speciosus* and *Achillea millefolium* frequently, and *Galium, Cirsium centaureae,* and *Potentilla* sp. occasionally). At other high altitude Colorado locations, I found *helloides* associated with *Rumex densiflorus* (near Weminuche Pass, 11000-11500', Hinsdale Co. Colorado) and *Rumex occidentalis* (Tennessee Pass, 10400', Eagle Co. Colo.). In Colorado, high altitude *helloides* are generally found along creeks where *Rumex* grows,

or in valley bottoms where *Polygonum douglasii, P. aviculare,* and *Rumex acetosella* grow on gopher diggings.

At low altitude in Colorado, *helloides* is associated with *Rumex crispus* and *Polygonum pennsylvanicum* (near Canon City, 5300', Fremont Co. Colo.) The lower altitude *helloides* was found on *Rumex triangulivalvis* (an egg found on dead leaf below plant, slough 4 mi. E. Moffat, 7600', Saguache Co. Colo., 29 August 1977, identical to dissected eggs). *Potentilla* also is common in the sloughs at this Moffat locality, but *helloides* was found only where Polygonaceae occurred and was not found in pure stands of *Potentilla.*

Chambers (1963) found *helloides* associated with *Rumex* at Gunnison, Gunnison Co. Colorado (7680'), and reared larvae to adults on *Rumex crispus.* Another population at Gothic (10000') in Gunnison Co. was abundant in a field with no *Potentilla.*

The above foodplant records clearly demonstrate that high-altitude Colorado *helloides* feed on Polygonaceae, like *helloides* outside of Colorado, and not on *Potentilla* as does *dorcas* exclusively.

WING PATTERN

The key finding in resolving the taxonomy in the *dorcas-helloides* complex is that both are sympatric, synchronic (during the second brood of *helloides*), and do not intergrade over a broad area in northwestern Ohio, Michigan (Moore 1960), and southern Manitoba. *L. dorcas* and *helloides* must be treated as two separate species in this region. Populations elsewhere must be identified as one or the other according to whether they resemble *dorcas* or *helloides* from the Michigan region.

I examined series of both species collected 2 mi. No. of Highway 59, Livingston Co. Michigan, Fenton Road, 20 July 1971, by John Hafernik. At this locality *dorcas* occurs in the bogs around *Potentilla fruticosa,* whereas *helloides* occurs along roadside ditches associated with Polygonaceae. *L. dorcas* has one brood there, *helloides* three broods there.

L. dorcas and *helloides* differ in Michigan by eight wing pattern characters. They do not differ in male or female genitalia. These wing characters are described below, the differences between the species are noted, and the relation of high-altitude Rocky Mountain material to the Michigan populations is dis-

cussed. More than 600 individuals were examined.

The figure of *L. helloides* in Howe (1975), plate 55 fig. 13, is too dark ventrally to be an average representative of *helloides*, and the figures of "*dorcas*" plate 97 figs. 18 and 22, and "*cupreus*", plate 97 fig. 25, appear to be actually *helloides*.

1) Size. *L. dorcas* males average 12-13 mm forewing length, whereas Michigan *helloides* males (and males from Rocky Mountain high altitudes) average 14-15 mm. Females average about 1 mm larger than males from all localities observed.

The next five characters (2-6) are similar in males and females.

2) Forewing shape. *L. dorcas* has rounded wings, whereas *helloides* has more pointed forewings. Rocky Mountain material from all altitudes is clearly like *helloides*, with more pointed forewings.

3) Ventral hindwing red marginal band. *L. dorcas* has brown dots basal and distal to the red band between the wing veins, which accentuates the red band, whereas *helloides* lacks these brown spots bordering the red band. Rocky Mountain material from all altitudes clearly resembles *helloides* in this character, although an occasional specimen has a trace of these brown spots.

4) Position of the forewing postmedian black spots (ratio of the distance from wing base to postmedian spot in cell M_1 to length of forewing). *L. dorcas* has a smaller ratio which averages .68, versus .71 for *helloides*. Rocky Mountain material is again similar to *helloides*: low altitude (Lakewood, Jefferson Co. Colorado, 5500') specimens average .73, high altitude specimens (Keystone Gulch, Summit Co. Colo., 9600') average .71.

5) Color next to ventral hindwing postmedian spots. *L. dorcas* has the ground color darker medial than distal to the black spots, whereas in *L. helloides* the color is the same medial as distal. Rocky Mountain material is again most similar to *helloides;* ground color is the same basal as distal to the spots, except for occasional individuals from high-altitude populations which are similar to *dorcas*.

6) Ventral hindwing ground color. *L. dorcas* has the ground color purplish brownish ochre, whereas *helloides* has the color ochre to grayish ochre. Rocky Mountain material is closest to *helloides*, although at high altitude ground color is often darker.

The next two characters (7 and 8) have been used to assign populations to *dorcas* or *helloides*. However, I now show that both characters are too variable in high altitude Rocky Mountain

populations to be really useful in assigning them to *dorcas* or *helloides*.

7) Male dorsal hindwing marginal band. In *dorcas* there is usually only one small red spot at the anal angle, whereas in *L. helloides* there is usually a complete red band of 4-5 spots. Table 1 gives the number of orange spots. Variation in this character is similar to that of the next so it will be discussed below.

8) Female dorsal color. *L. dorcas* is brown, sometimes with postmedian orange spots; it has very little sexual dimorphism. *L. helloides* has most of the forewing and the distal half of the hindwing orange except for a marginal border. Table 2 details this character. For both characters 7 and 8 there is considerable variation. Some *helloides* females from California are as dark as some *dorcas*. Most lowland western U.S. material is most similar to Michigan *helloides*. Higher altitude material is darker, including a subspecies from Broadwater, Cascade, and Sweetgrass Counties, Montana, and Yellowstone National Park, Wyoming, which has the dorsal orange of females replaced by whitish and the ventral hindwing red marginal band reduced. In Colorado, plains material is like Michigan *helloides*, as is material from the Arkansas River Canyon, Wet Mountain Valley, and San Luis Valley in southern Colorado (all of which have several broods). The lightest population in Colorado is from the floor of the San Luis Valley, 7600'. This valley is high, fairly cold, but dry, so that if light-dark phenotypes are environmentally determined in *helloides*, moisture in addition to temperature may affect the phenotype. High altitude (9000-11500') material from northern and central Colorado (the Front Range and Sawatch Range) averages darker than material from the San Juan Mountains in southwestern Colorado which in turn averages darker than material from the Sangre de Cristo and Wet Mountains in southern Colorado. Material from lower altitudes in northwestern, extreme western, and southwestern Colorado is intermediate between high altitude and lowland material.

The two wing pattern characters 7-8 are darker on the average in high altitude specimens, but they are variable (Tables 1-2), and I have never seen a Rocky Mountain *population* resembling *dorcas* in these two characters, although single individuals may do so. The dark individuals are always found to be part of a variable population including light individuals, and all Rocky Mountain populations and these dark individuals have

their other characters (characters 1 to 6 above) resembling *helloides.*

DISCUSSION

9000' is the approximate boundary for voltinism in Colorado. Only one brood occurs in *helloides* populations above 9000', whereas two to three broods occur below 9000'.

L. helloides has a wide range, while *dorcas* may prove to be restricted to southeastern Canada and adjacent U.S., and perhaps northwestward to Alaska where Ferris (1977) lists *L. dorcas dorcas.* I have seen *helloides* from the Yukon in Canada. Ferris's (1977) *dorcas* subspecies *castro* (Reakirt), *megaloceras* (Ferris), *florus* (W. H. Edwards), and *arcticus* (Ferris) appear to all belong to *helloides.* Despite the very extensive overlap of the ranges of these four taxa with *helloides* shown on Ferris's maps (1977, Figs. 48,49), Ferris indicates that nowhere are they sympatric. He does, however, give many locations where "intergrades" and "introgressed populations" are found between *helloides* and these four taxa (Ferris 1977, p.35-36, 38). These difficulties of intergradation, introgression, and lack of sympatry between species caused by placing these four taxa into *dorcas* all vanish when it is realized that these four taxa actually belong to *helloides.* Some of the subspecies may result from darkening the wings or altering the phenotype due to temperature or humidity differences at high altitude or latitude. Ferris limits the subspecies *megaloceras* to the Bighorn Mts. Wyoming, but similar phenotypes with reduced hindwing submarginal orange lunules and whitish females occur more widely in Wyoming and southern Montana (Tables 1-2).

Ferris (1977) cites Coolidge (1924) to show that *helloides* winters as pupae (whereas *dorcas* winters as eggs), implying a biological difference between the species. Coolidge (1924) was probably wrong, however, because the preponderance of the evidence is that *L. helloides* over-winters as eggs. Shapiro (1974c) lists "larva or pupa" as the wintering stage of *helloides,* but later clarified his statement in a letter to me, stating that *helloides* probably over-winters as eggs, which hatch in late January in California. Chambers (1963) thought that his Gothic, Colorado, material wintered as eggs. Guppy (1964) specifically states that Vancouver Island, Canada, *helloides* spend the winter as eggs. Finally, all the *helloides* eggs from low and high altitude that I have found entered the winter without hatching.

CONCLUSION

High altitude Rocky Mountain *Lycaena* of the *dorcas-helloides* complex has as hostplants at least five species of Polygonaceae, the foodplant family used by *helloides,* rather than *Potentilla,* the hostplant of *dorcas.* Eight wing pattern characters which distinguish Michigan *dorcas* from Michigan *helloides* are, in high altitude Rocky Mountain populations, most similar to *helloides,* except for several wing pattern characters which are variable. High altitude Rocky Mountain populations are therefore *helloides,* not *dorcas.*

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Table 1. Number of orange lunules on margin of male dorsal hindwing. *—several generations per year; the other locations have only one generation per year (except perhaps the Minturn and Piney Creek locations in Colorado).

	Number of Lunules					
	0	1	2	3	4	5
A. *L. dorcas* (Michigan, Ontario)	3	11	3			
B. *L. helloides*						
*Michigan					1	3
*California				5	27	10
*Oregon, Washington				2	4	1
*lowland Nevada				1	9	9
Ruby Mts. Nevada		1		2	2	1
*lowland Utah, Idaho, Montana				1	3	9
*Twin Falls Idaho			3	3	5	3
mountainous Utah, Idaho, Wyoming, Alberta		3	1	5	4	1
subspecies with whitish females (Broadwater, Cascade, Sweetgrass Cos. Montana, and Yellowstone National Park Wyoming)		7		1		1
Colorado						
*plains (5000-6000')			1	6	41	64
*Wet Mtn. Valley and Salida (7000-8400')				2	16	17
*floor of San Luis Valley (Saguache Co.) 7600'						9
*mesas southwestern Colo. (La Plata Co.) 7500'		2	1	4	4	
*northwestern Colo.		1	2	1	4	
mountains Front and Sawatch Ranges	3	78	88	36	18	1
Minturn, Eagle Co., 8000'	2	6	5	4	4	
Piney Creek, Eagle Co., 7000'		5	8		3	
Keystone Gulch, Summit Co., 9600'		27	25	13	3	
Toll Ranch, Gilpin Co., 9400'	1	19	16	4	2	
Jim Creek, Grand Co., 9400'		7	9	2	1	
Arapahoe Pass Trail, Boulder Co., 11000'		5	4	3	1	
Fall River Res., Clear Creek Co., 10000'		3	5	5	1	
mountains Sangre de Cristo and Wet Mtn. ranges		3	23	25	9	1
West Creek Lake, Fremont Co., 11600'		1	5	3	1	
Ferguson Creek, Saguache Co., 9500'			4	4	3	
mountains San Juan range		6	8	5	3	
Weminuche Pass, Hinsdale Co., 11400'		3	2	1		
Spring Creek Pass, Hinsdale Co., 11000'		2	5	2	2	

Table 2. Extent of orange on dorsal forewing of females (A—completely brown; B—brown except for postmedian orange spots; C—postmedian band orange and some median orange spots; D—postmedian band solid orange and median part of wing mostly orange; E—orange except for basal third of wing and margin; F—completely orange except for darker wing base and margin.

	brown				orange	
	A	B	C	D	E	F
A. *L. dorcas* (Michigan, Ontario, Manitoba)	11	3				
B. *L. helloides*						
Michigan				1		
California		3	2	5	2	
Oregon, Washington			1	1		1
lowland Nevada			5	3	2	
lowland Utah, Idaho, Montana, North Dakota				2	1	2
Twin Falls Idaho			3	5		
mountainous Utah, Idaho, Wyoming, Alberta	1		3	3		
subspecies with whitish females (Broadwater, Cascade, Sweetgrass Cos. Montana, and Yellowstone National Park Wyoming)	1	2	5		1	
Colorado						
plains				3	16	6
Wet Mtn. Valley and Salida		[illegible]				
floor of San Luis Valley, Saguache Co.					3	9
mesas southwestern Colo. (La Plata Co.)		1	5	3	1	
western and northwestern Colo.			5			1
mountains Front and Sawatch Ranges	6	17	23	18	3	1
Piney Creek, Eagle Co.	2	2	3	1		
Keystone Gulch, Summit Co.	3	8	11	11	2	
Toll Ranch, Gilpin Co.		3	2	2	1	
Jim Creek, Grand Co.	1	2	2			
Arapahoe Pass Trail, Boulder Co.				1		
mountains Sangre de Cristo and Wet Mtn. ranges			5	4	8	
West Creek Lake, Fremont Co.			3	2		
Ferguson Creek, Saguache Co.			1	1		
mountains San Juan Range		4	6	10	2	
Weminuche Pass, Hinsdale Co.		3	6	9		
Spring Creek Pass, Hinsdale Co.					2	